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MSE 260: Surface Properties of Materials

Introduction

- Surfaces are the frontier of the material: Compared to atoms in the bulk, the surface atoms there have broken chemical bonds and experience less attraction (electrostatic, van der Waals) from the rest of atoms. This gives rise to an energy per unit area
- The surface structure therefore is expected to be different from that expected from that resulting from an ideal termination of the bulk.

Surface science = analog to bulk solid state science.

“Refresher” lectures will be given to help those not familiar with Solid State Physics.

Textbooks and notes:

Notes for each lesson will be provided.

Some interesting books:

Introduction to Surf. Chem. And Catalysis

Physical Chemistry of Surfaces

Physics at Surfaces

Introduction to Solid State Physics

Solid State Physics

Surface Science

Intermolecular and Surface Forces

Concepts of Modern Catalysis and Kinetics

Volume 5 of Landau and Lifshitz

Surface Forces

Somorjai and Li. Wiley.

Arthur Adamson. John Wiley & Sons

Zangwill (Cambridge)

Kittel

Ashcroft and Mermin

K. Oura, V.G. Liffshits et al. Springer

Israelachvili (Academic Press)

Chorkendorff and Niemanstverdriet

B.V. Derjaguin, N.V. Churaev and V.M.

Muller. Plenum Press

Where surfaces are important:

- Heterogeneous catalysis is a surface enhanced chemical process
- Semiconductor surfaces give rise to special electronic effects
- Electrochemistry, Fuels cells, Batteries
- Environmental phenomena: rock weathering, atmospheric phenomena
- Oxidation, Corrosion
- Crystal growth
- Tribology: friction, adhesion, wear, MEMS
- Nanoscience: Surface atoms can be a large % of total. Nanoscience research Institutes
- Emergent phenomena: graphene, 2D physics, Topological Insulators

My group performs research on various surface science topics since the early 1980's.

Here is a summary of where my students / postdocs have gone to after graduation:

Academia (Univ. and Res. Labs) 46 (1990-2012)

Industry: 20 (1990-2012)

Other: 14 (1990-2012)

Syllabus Spring 2015

<u>Dates</u>	<u>Topic</u>
19-Jan	MLK holiday
21-Jan	+
26-Jan	Introduction to Surface Science
28-Jan	Surface tension, drops and bubbles. Nucleation
2-Feb	Equilibrium Shape. Wulf's Theorem. Reconstruction
4-Feb	Surface forces, contact angle, wetting
9-Feb	Review Thermodynamics of surfaces
11-Feb	Experimental Surface Science, vacuum, preparation
16-Feb	Composition characterization: AES, XPS, ISS, SIMS
18-Feb	Reciprocal lattice and Diffraction
23-Feb	Reciprocal lattice and Diffraction
25-Feb	Electronic Structure
2-Mar	Electronic Structure (GRC)
4-Mar	Midterm Exam
9-Mar	Photoemission
11-Mar	Photoemission
16-Mar	X-ray absorption and emission (DPG)
18-Mar	X-ray absorption and emission (DPG)
23-Mar	Review electronic structure and spectroscopies
25-Mar	SPRING RECESS
30-Mar	SPRING RECESS
1-Apr	Surface Chemistry, Chemisorption
6-Apr	Surface Chemistry, Chemisorption
8-Apr	Scanning Tunneling Microscopy
13-Apr	Scanning Tunneling Microscopy
15-Apr	Scanning Tunneling Microscopy
20-Apr	Atomic Force Microscopy
22-Apr	Atomic Force Microscopy
27-Apr	Tribology: friction and lubrication
29-Apr	Surface Forces apparatus
4-May	Non-contact AFM
6-May	NSOM, Plasmonics, TERS
11-May	Course Review
13-May	Final Exam